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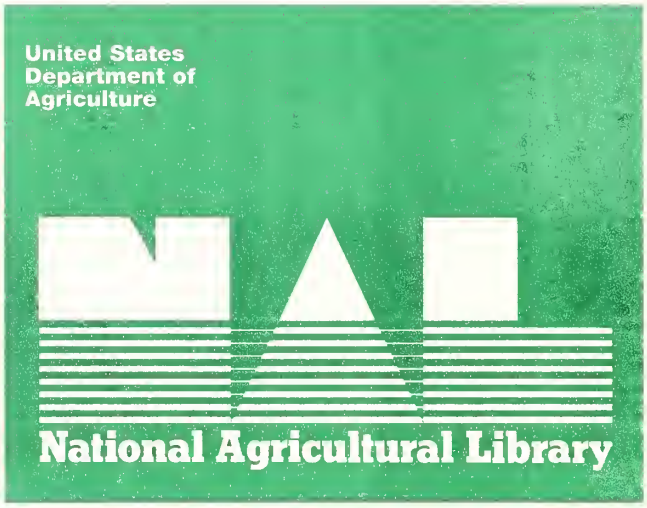
Sound Levels of Five Motorcycles Travelling Over Forest Trails

Rock Creek ORV Area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Rock Creek ORV Area

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Introduction

The Rock Creek area of the Georgetown Ranger District on the Eldorado National Forest is an area of long-term traditional motorcycle use and the site of a well established annual enduro. As part of the Ranger District's land use plan, an environmental impact statement on motorcycle use in the Rock Creek area has been required. The District Ranger contacted the Technology and Development Center at San Dimas for assistance in the development of the noise segment of the required environmental impact statement.

The noise of the motorcycles is hypothesized to have potential impact in two areas; one, impact on wildlife; second, impact on other Forest users and adjacent landowners. This report presents results of a brief study carried out by the Technology and Development Center in the Rock Creek area. It presents recommendations for mitigation of any noise effects from motorcycles, and for further studies.

Current Standards and Knowledge

As regards wildlife, there is a great deal of anecdotal information about noise effects on animals in general and wildlife in particular reported in the professional literature. However, most does not focus attention on biologically meaningful effects such as changes in reproductive output,health agents, sex related mortality, habitat use or distribution and abundance. Also, most of the reported literature does not quantify the acoustical "dose" sufficiently to reach meaningful conclusions as to the effect of noise on the animals studied.

A recent extensive literature study (Ref. 1) prepared for the National Park Service concludes that "no overall study plan, theoretical model, or clear statement of goals has guided (wildlife studies). As a result nearly all the work is consisted of short term studies addressing immediate controversies. This approach has not lead to useful predictions about the effects of (noise) on wild animals because; one, a biologically meaningful impact is likely to be small hence not detectable by typical short-term studies for small samples sizes; two, the behavioral response generally used is largely unrelated to significant health or population dynamic effects; and, three, the impact of noise is often masked by larger natural and anthropogenic effects." Although the study cited deals in particular with overflights and the noise of aircraft, the conclusions are equally applicable to noise from off-road vehicles. Also, this study concludes that most animals habituate readily to the presence of noise. It is likely that animals indigenous to Rock Creek will avoid the immediate area of intense motorcycle use. At the distances that they are likely to retreat to, the sound level from the motorcycles will not be loud enough to cause physiological changes to the animals hearing mechanisms.

The second area of concern is effect of motorcycle noise on humans. Although the effects of community noise levels on people has been extensively studied, only one major study has been published which specially targets the effects of noise, in this case aircraft overflight noise, on visitors to wilderness areas (Ref. 2). A 1980 study (Ref. 3) sets forth a theoretical framework for the study of the problem of off-road vehicle noise on National Forest visitors, and presents a method for predicting this impact.

The U.S. EPA, in its "levels document" (Ref. 4) sets a Day Night level of 55 dBA as "the level necessary to protect human health and welfare with an adequate margin of safety" for outdoor recreation areas. Day Night level is a way of measuring sound over a 24 hour period, and averaging the energy of that sound to come up with a single descriptor.

Day Night level and the closely related metric equivalent level proceed on the assumption that equal sound energy results in equal human reaction. That is, the same number of people will be moved to complain, for instance, if they are subject to a noise of X dB for 1 hour, or of X minus 3dB (half the energy) for 2 hours. There are a number of reasons why this as-

sumption works in the community noise scenario. People are used to the surroundings. The sounds they hear are not likely to be startling, nor are they likely to carry particularly emotional messages. Further, the sounds are likely to be more or less continuous, and more or less of the same level. Also, Day Night level "penalizes" sounds heard at night, when people are likely to be most sensitive to sound instrusion. For these reasons, almost all community noise level standards are written in terms of Day Night level.

Since almost all motorcycle use in the Rock Creek area is day use, it seems illogical to attempt to measure motorcycle sound on a 24 hour basis. Excluding the nighttime levels that our experience has shown would be present at Rock Creek does not introduce serious error into the calculation. Also, it is not expected that motorcycle sound would be continuous, but limited to fairly short periods. For this reason, we use as a benchmark a 5 minute equivalent level, that is, the "average" sound level over 5 minutes, to assess both motorcycle sound and naturally occurring sound. This allows a comparison of the two, that is, allows us to determine whether or not the motorcycles increase the sound level at a given location.

It should be mentioned at this point that a sound source such as a motorcycle can be clearly audible above the background, in some cases, even though its measured sound level is below that of the background. Explanation of this phenomenon is beyond the scope of this paper, curious readers are referred to References 5 and 6.

Another sound standard which is currently in place is that of the Occupational Safety and Health Administration (Ref. 7). This standard is 90 dBA at the listeners ear for 8 hours per working day. This is the level that most authorities in the United States believe is necessary to protect against hearing loss over a 20 year working career. As the data below will show, only the motorcycle riders themselves and people who test the motorcycles using SAEJ1287 (described below) are subjected to sound levels anywhere near this limit.

Reference 1 shows the response of wilderness visitors as a function of Day Night level. The authors acknowledge that this is a theoretical relationship, and needs further testing. However this relationship is probably the best documented and most scientifically defensible approximation of population reaction to noise in wilderness that has been published.

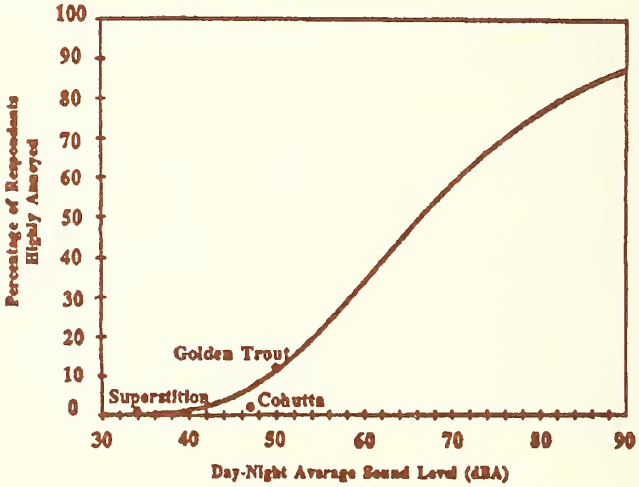

Figure 1. Prevalence of annoyance in three wildernesses in relation to theoretical dosage-response relationship for residential exposure.

Measurements

The goal of the measurements described in this report was to gather data for an environmental impact statement that would satisfactorily address the issue of motorcycle noise in the Rock Creek area. The objective was to gather equivalent, maximum, and minimum sound levels from 3 locations while 5 motorcycles traversed 2 separate courses. Background sound at each measuring location was also assessed. The time base for the equivalent level measurements was 5 minutes. All measurements were frequency weighted by the A scale. For a definition of this frequency weighting, and justifications for its use, see Reference 8, particularly chapters 2, 3, 11 & 23.

Georgetown District personnel assembled 5 motorcycles and riders from the local area. All the motorcycles were tested in accordance with SAEJ1287 procedures.

This method, which evaluates the acoustic output of a motorcycle for enforcement purposes, is used by both the State of California and the U.S. Forest Service in the enforcement of motorcycle noise regulations. The non-exceedence level, when tested by this method, is 101 dBA. These tests were performed using a type 1 sound level meter. (Ref. 8)

Table 1 shows the description, and the test results, of the SAEJ1287 tests on each of the test motorcycles.

Table 1

Test Motorcycle Statistics

Make	Year	Model	Test rpm	SAE J1287 dBA
Yamaha	1987	350	4250	87
Honda	1987	250XR	4500	83
Kawasaki	1980	175KDX	4750	101
Honda	1986	250R	4000	88
Yamaha	1980	400	3500	100

To measure motorcycle noise at the measurement locations, two Bruel and Kjaer precision model 2231 sound level meters programmed with BZ7107 event recording modules were used. Model 4155 microphones and windscreens were employed. Instrument response was set on fast, each instrument was calibrated prior to each test. As mentioned above, the time base for equivalent level measurements was 5 minutes.

To conduct the tests, the motorcycles were positioned at the starting point of each motorcycle course. The riders were instructed to ride as they would normally ride in a group. Two-way radio was used to signal a start, the sound instrumentation was turned on 30 seconds later. After an appropriate period of time had passed, the motorcycles were shut off. Ambient sounds at each of the test locations without motorcycles running were also measured.

Measurement locations and riding courses are mapped in figure 2 and described as follows:

- Location A was on a knob along a ridge at an elevation of slightly over 3400 ft in an open Ponderosa Pine/ Manzanita stand with occasional Douglas fir and Black Oak. Brush blocked the view between this site and the starting point of the course #1. A second knob along the ridge, at the same elevation, was located between course #1 and this site. Traffic on a paved road north of Location A could occasionally be heard and may have contributed to background sound levels.

- Location B was located along a ridge trail below a 3472 ft elevation peak, at an elevation of approximately 3380 ft, in a medium Ponderosa/Manzanita stand with occasional Black Oak.

- Location C was near course #1 along a spur ridge with an elevation of 3220 ft, in an open Ponderosa/Manzanita stand with occasional Douglas fir. No land forms existed between this measurement location and most of test course #1, but the motorcycles could not be seen from the measurement location because of vegetation.

- Motorcycle course #1 traversed both sides of the ridge upon which location A was situated. The instruments were positioned about 1100 ft from the closest approach of the motorcycles, and 5000 ft from the farthest. Course 1 elevation varied between 3100 and 3300 ft.

Course #1 was located across a valley to the east from location B. The motorcycles were on the front side of the ridge relative to the test location at a distance of about 1900 ft at the nearest point and back side of the ridge at a distance of about 4000 ft. No major landforms intervened between the motorcycles and the measurement loca-

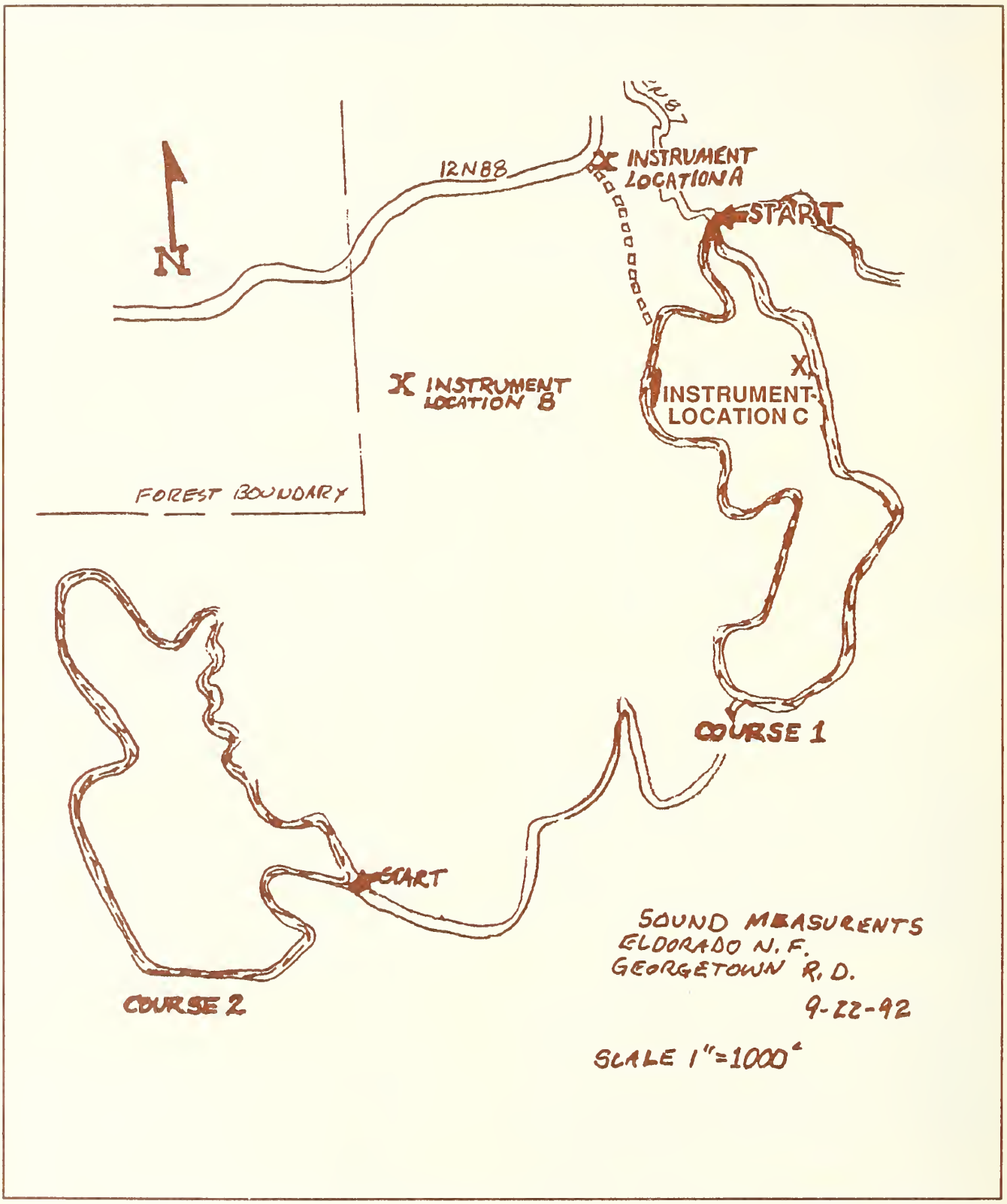

Figure 2. Location map. Sound measurement, Georgetown Ranger District, El Dorado National Forest.

tion, but line of sight was obscured by vegetation.

This course completely circumnavigated location C. Motorcycles passed within 400 ft of this location while traversing the course, the maximum distance was 2700 ft. Line of sight was obscured by vegetation only.

• Course #2 was used only when the instrumentation was placed at location B. This course was to the southwest of location B along gentle mountain slopes. At the nearest point, it was 2500 ft from the instruments, at the same elevation. The farthest point was about 1 mile away.

Discussion

The results of the tests are shown in Table 2, and summarized inTable 3.

Note from Table 2 that for 5 of the tests, the presence of motorcycles increased equivalent or maximum level. But for 3, the level was *lower* when motorcycles were present than when only the natural background sound was present. Maximum level measured in the 5 minute measurement period is subject to random spikes, of both motorcycle noise and of pseudo-noise caused by the gusty winds which were present during the test. These results show the futility of attempting to describe a complex phenomenon like motorcycle noise with a single peak measurement number.

Note that half of the maximum levels measured were louder with motorcycles present, and half were louder *without*.

Table 2
Field Data

Run #	Start Test Time	Location of Measure.	Cycles on Course #	Equiv Level Mtr 1/Mtr 2 (dBA)	Max Level Mtr 1/Mtr 2 (dBA)	Min Level Mtr 1/Mtr 2 (dBA)	Remarks
1	0944	A	1	34.4/37.1	52.6/63.0	23.7/26.2	Motorcycles clearly audible
2	0954	A	1	33.2/35.2	48.5/54.4	25.2/26.2	Motorcycles clearly audible
4	1021	A	-	32.8/35.0	44.7/52.3	25.7/26.4	Distant aircraft barely audible for 1 minute, second aircraft clearly audible for 1.5 minute
5	1039	B	1	37.8/37.7	53.7/56.2	23.0/23.8	Aircraft clearly audible 1.5 min. Wind noise greater than Location A. Motorcycles not audible
6	1056	B	1	35.2/35.7	51.3/51.7	24.5/24.7	Distant prop aircraft heard for 1.5 min intermittently. Motorcycles not audible
7	1105	B	-	32.9/33.7	49.4/49.4	23.4/24.3	Bird chirping dominant noise
8	1114	B	-	37.7/37.7	67.0/63.3	24.8/25.0	Wind gusts stronger than run 7, Distant plane heard 1/2 minute
10	1149	C	1	45.6/45.2	66.5/68.8	36.4/31.1	Motorcycles clearly audible - gusty wind
11	1159	C	1	45.2/46.1	58.9/77.9	32.8/32.5	Motorcycles clearly audible - gusty wind
9	1140	C	-	43.7/42.7	58.9/52.3	31.4/31.1	Gusty wind
12	1209	C	-	43.3/43.0	56.4/62.0	29.6/29.4	2 aircraft, 1 distant, audible total 3 min gusty wind
14	1240	B	2	40.7/40.1	55.0/54.7	24.5/24.0	Gusty wind, Aircraft audible 2.5 min Motorcycles audible last 1.5 min
13	1231	B	-	47.2/46.7	63.9/61.7	29.5/28.9	Gusty wind

Table 3.
Data Summary

Measrmt Location	Motorcycles on Course #	(dBA) Equivalent level No Mtrcycl	(dBA) Equivalent level With Mtrcycl	(dBA) Maximum level No Mtrcycl	(dBA) Maximum level With Mtrcycl
A	1	34	35	49	55
B	1	36	37	57	53
B	2	47	40	62	55
C	1	43	46	57	67

The minimum level recorded in the 5 minute measurement period was controlled exclusively by wind and other ambient noise, and showed no significant differences between motorcycle and no-motorcycle conditions.

The equivalent level data in Table 3 shows more consistency, with 3 of the levels increasing with the presence of motorcycles. Notice however that the largest increase was only 3 dBA, well within experimental error. Note also that at site B with motorcycles on course 2, background conditions were such that a significant 7 dBA difference was seen between the no-motorcycle and with-motorcycle condition in the direction opposite to that which might have been expected. Table 2 shows that the wind was gusty at these measurement sites, and the motorcycles were audible for only 1.5 minutes of the 5 minute measurement period.

No attempt was made to accurately determine at what distance motorcycles could or could not be detected. The detection of audible signals in a background sound is an extremely complicated statistical process, which is not useful for the prediction of the audibility of specific incidents. The measurements made were an attempt to determine whether or not the motorcycles, as typically used for off-road recreation, on typically used riding courses, were likely to cause a measurable impact upon the environment at typical listening locations. The data confirm that, although in some cases the motorcycles were audible at the measurement locations (could be detected as being present by carefully listening observers who knew what they were listening for) no measurable sound increase occurred.

Conclusions

1. The data gathered substantiates that at distances of 400 ft or greater, motorcycles which meet the State of California and USDA Forest Service 101 dBA limit will not cause sounds loud enough to impact the hearing of people.

2. Extrapolating from the above, the same conclusion with regard to the hearing mechanism of animals may be drawn. No direct physiological effect upon animals in the area could be expected from the sound of the motorcycles.

3. At distances of 400 ft or greater, it is impossible to say that 5 motorcycles normally ridden increase the measurable ambient sound level, when such level is assessed using equivalent level.

4. Sounds produced by 5 motorcycles ridden on typical motorcycle trails are detectable, at least occasionally, by observers listening for motorcycles at distances up to one half mile under terrain, vegetation and weather conditions presented in the Rock Creek OHV area.

Recommendations

1. Because the major effect of motorcycle noise under normal recreational use in the Rock Creek area will be annoyance to other users, where motorcycle use is expected, some notice to other users that they may encounter motorcycle sound in the area should be given.

2. Only normal recreation use, not the intensive use that occurs during an enduro, has been evaluated by this study. SAEJ1287 levels and environmental levels should be obtained during the next enduro.

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